FAST-NEUTRON ELASTIC SCATTERING FROM ELEMENTAL VANADIUM

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ABSTRACT

Differential neutron elastic- and inelastic-scattering cross sections of vanadium were measured from 4.5 to 10.0 MeV. These results were combined with previous 1.5 to 4.0 MeV data from this laboratory, the 11.1 MeV elastic-scattering results obtained at Ohio University, and the reported neutron total cross sections to energies of ≈ 20.0 MeV, to form a data base which was interpreted in terms of the spherical optical-statistical model. A fit to the data was achieved by making both the strengths and geometries of the optical-model potential energy dependent. This energy dependence was large below ≈ 6.0 MeV. Above ≈ 6.0 MeV the energy dependencies are smaller, and similar to those characteristic of global models. Using the dispersion relationship and the method of moments, the optical-model potential deduced from the 0.0 to 11.1 MeV neutron-scattering data was extrapolated to higher energies and to the bound-state regime. This extrapolation leads to predicted neutron total cross sections that are within 3% of the experimental values throughout the energy range 0.0 to 20.0 MeV. Furthermore, the values of the volume-integral-per-nucleon of the real potential are in excellent agreement with those needed to reproduce the observed binding energies of particle- and hole-states. The latter give clear evidence of the Fermi surface anomaly. Using only the 0.0 to 11.1 MeV data, the predicted $E < 0$ behavior of the strength and radius of the real shell-model Woods-Saxon potential are somewhat different from those obtained by Mahaux and Sartor in their analysis of nuclei near closed shells. This is attributed to the neglect of higher-energy data in the extrapolation. Because of the dispersion relationship linking the real and imaginary potentials, it is argued that the use of a global optical model for interpreting low-energy data is suspect but, at the same time, probably a reasonable approximation at higher energies.